Measures to Limit Near-Term Climate Change and Improve Air Quality

The UNEP/WMO Integrated Assessment of Black Carbon and Tropospheric Ozone

and

Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security

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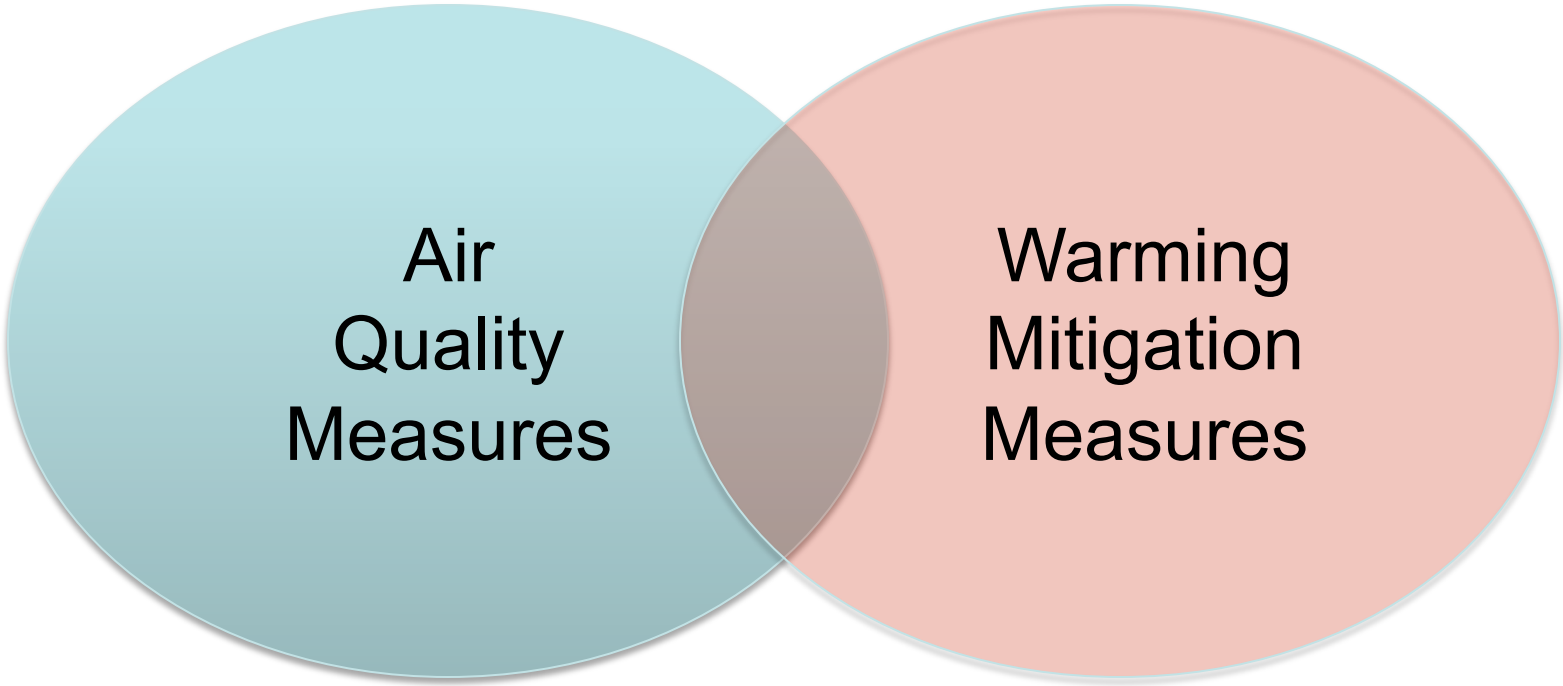
Assessment Objectives



Screening of measures in IIASA GAINS used GWP

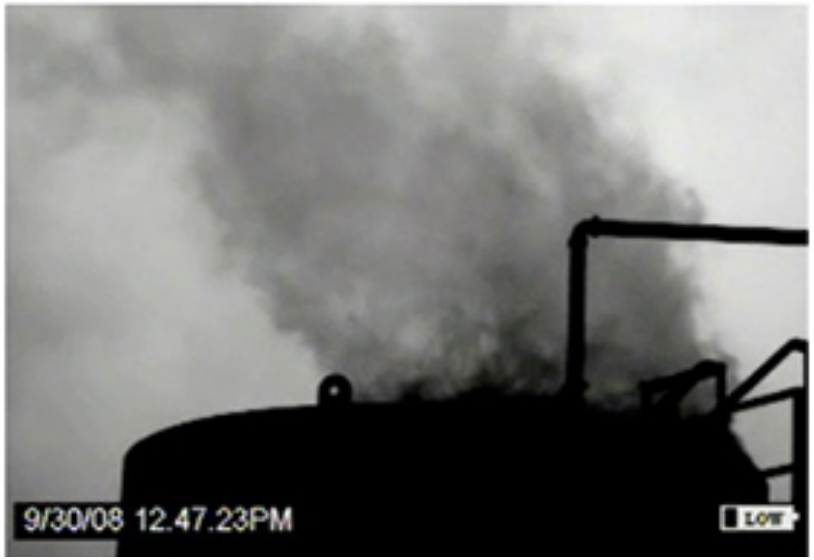
Emission Control Measures in the Analysis

- IIASA ranked mitigation measures by the net GWP of their emission changes (considering CO, CH_4, BC, OC, SO_2, NO_X, nmVOCs, and CO_2), picked the top measures

'Methane measures'

- extraction and long-distance transport of fossil fuels (~25%)
- waste management; municipal, landfills & wastewater (~10%
- agriculture; livestock manure & intermittent rice aeration (~5%)

(% reduction in 2030 relative to reference)



‘BC Measures’: those that reduce emissions of black carbon and co-emissions (e.g. OC, CO)

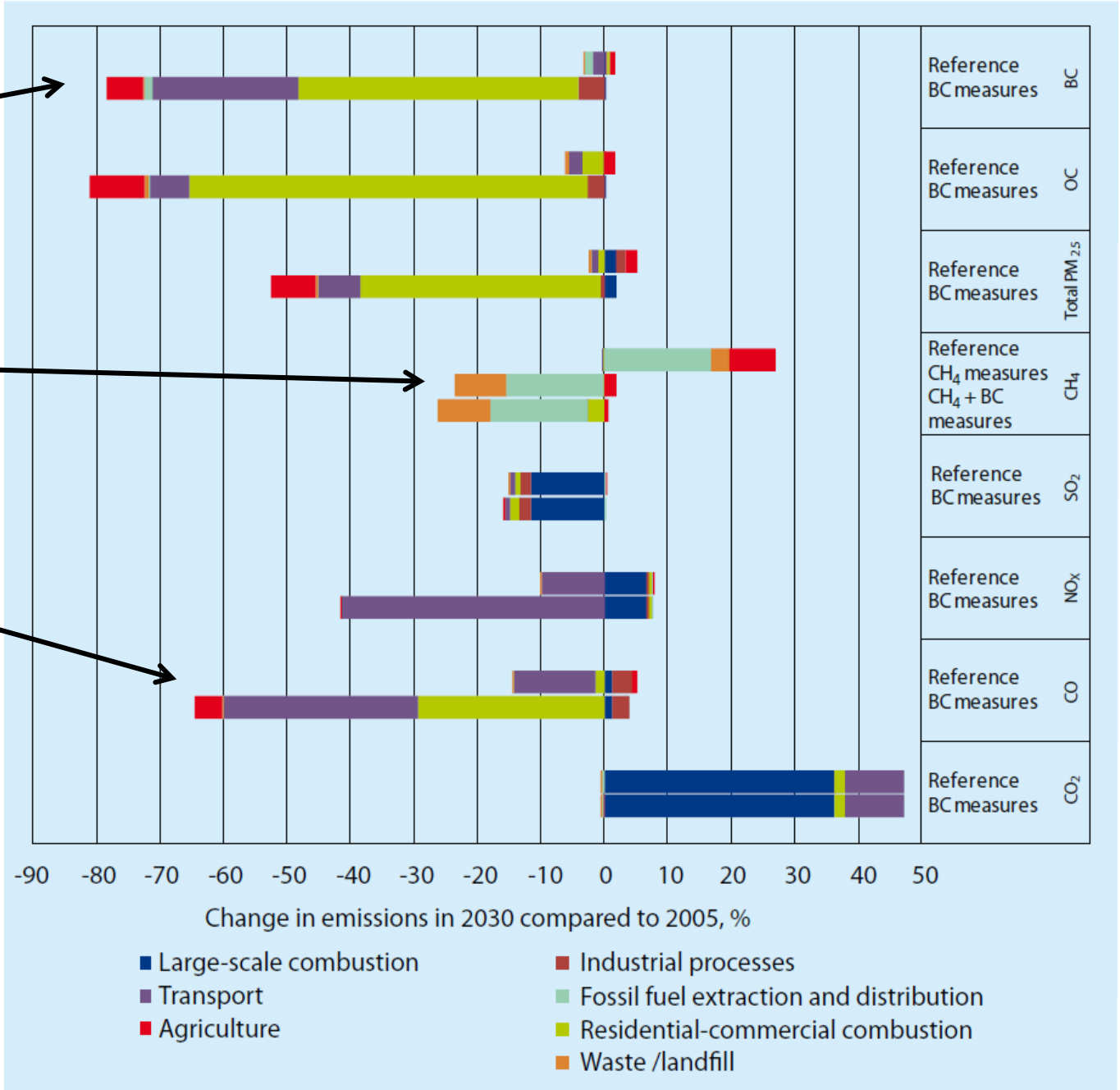
- Diesel vehicles (particle filters+)
- Coal briquettes replacing coal in residential stoves
- Pellet stoves & boilers replacing residential wood burning in Industrialized countries
- Clean-burning cookstoves in developing countries
- Modern brick kilns
- Modern coke ovens
- Ban of open burning of agricultural waste

Effect of measures on emissions projected in 2030 relative to 2005

9 BC measures reduce ~80% of BC

Reference: CH_4 increases
7 CH_4 measures reduce ~25% of CH_4 (2005); or ~ 40% relative to 2030

BC measures reduce CO



Methane and BC measures vs CO_2 measures

- CO_2 measures target power plants and large industry
- Methane and BC measures largely target other sectors
- Even for transportation, which emits substantial CO_2 and BC/OC/CO, diesel particulate filters impact the latter but not CO_2
- Emissions would be more related in a world with very substantial shifts to low carbon (e.g. electric cars/public transport) or with certain regulatory/behavioral changes not examined (e.g. fuel economy)

Result for Global Temperature Change (hybrid of results from GISS and ECHAM models and assessment of literature) added to the historical record

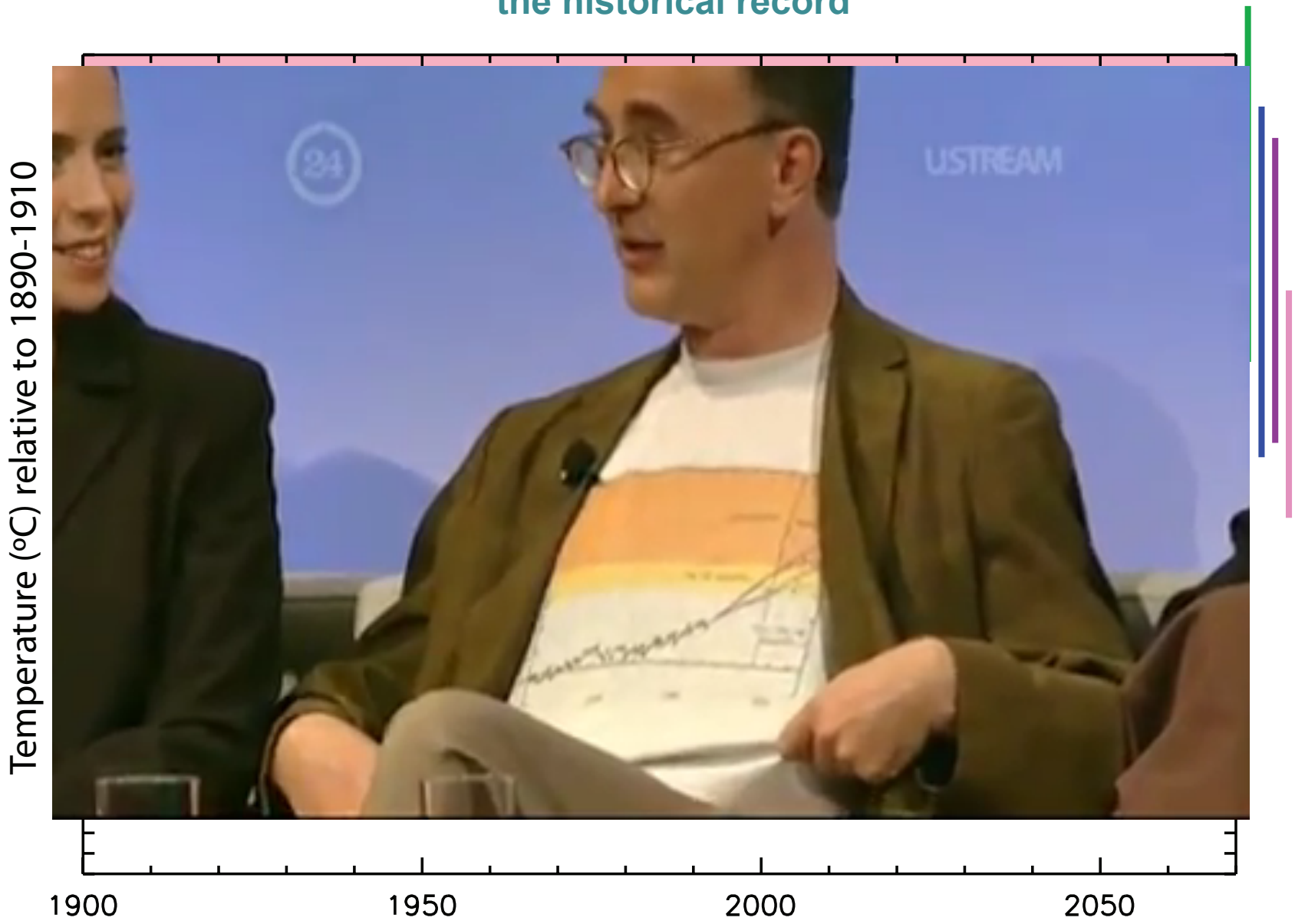
Impact of measures estimated using AGTP

Forcings based on % of anthropogenic forcing decrease due to measures times assessed forcing

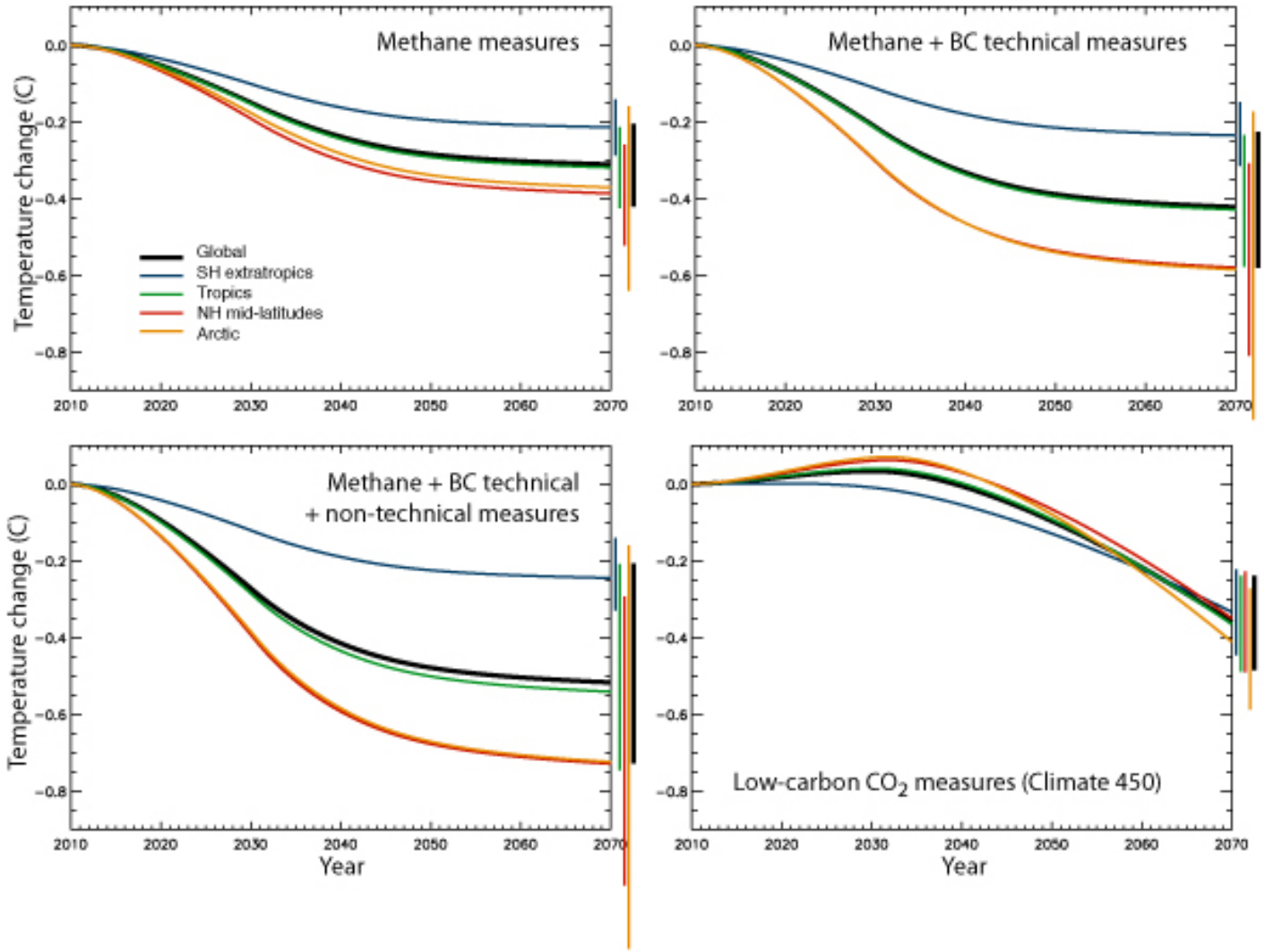
Caveats: BC assessed thoroughly for direct, semi-direct and indirect impacts, but AIE for other aerosols simply assigned to sulfate (more soluble than OC).

Note: Methane and aerosol forcings actually very consistent between GISS and ECHAM. Ozone less so.

Global Temperature Change (hybrid of results from GISS and ECHAM models and assessment of literature) added to the historical record



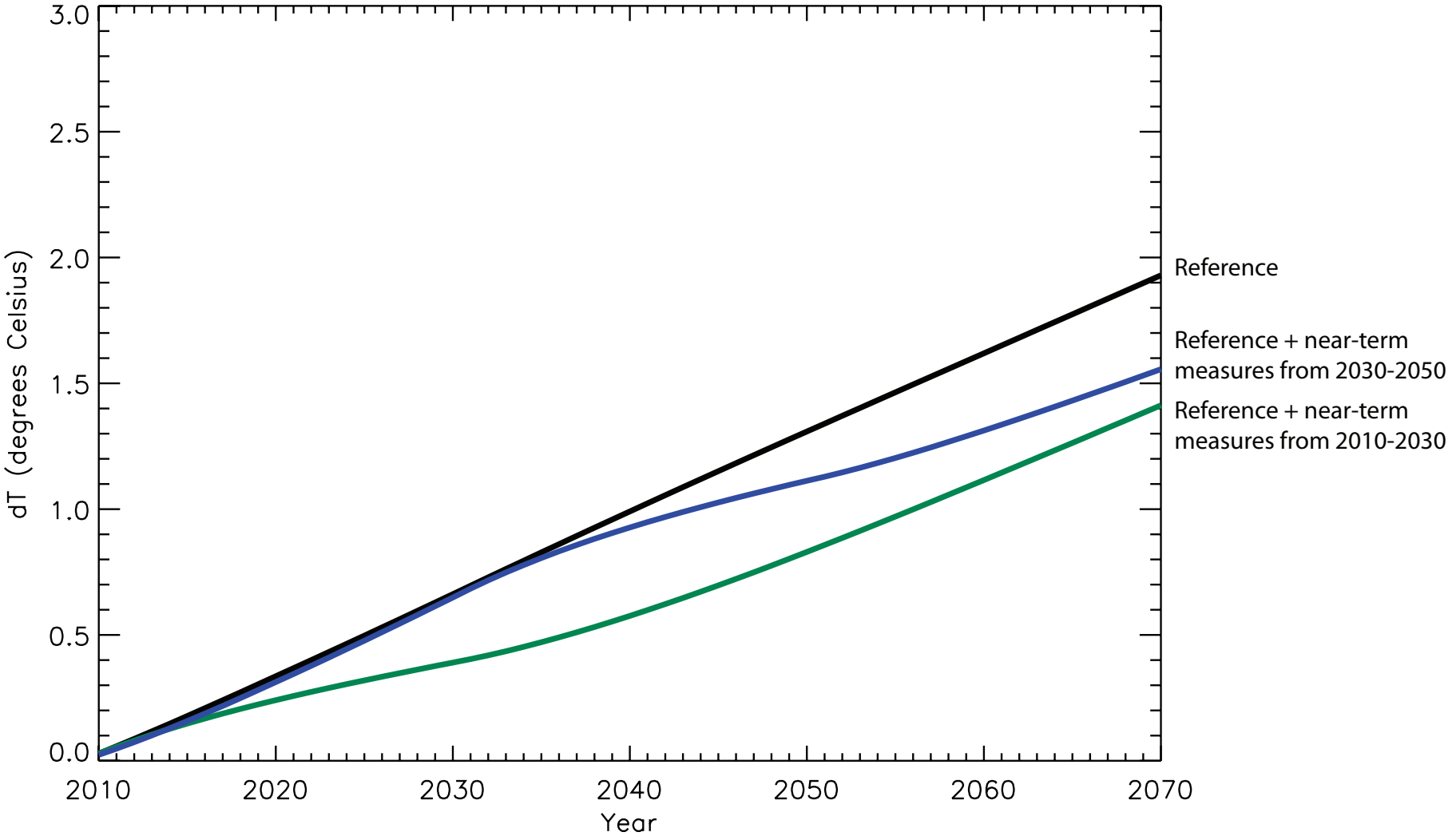
Regional Temperature Change (hybrid of results from GISS and ECHAM models and assessment of literature)



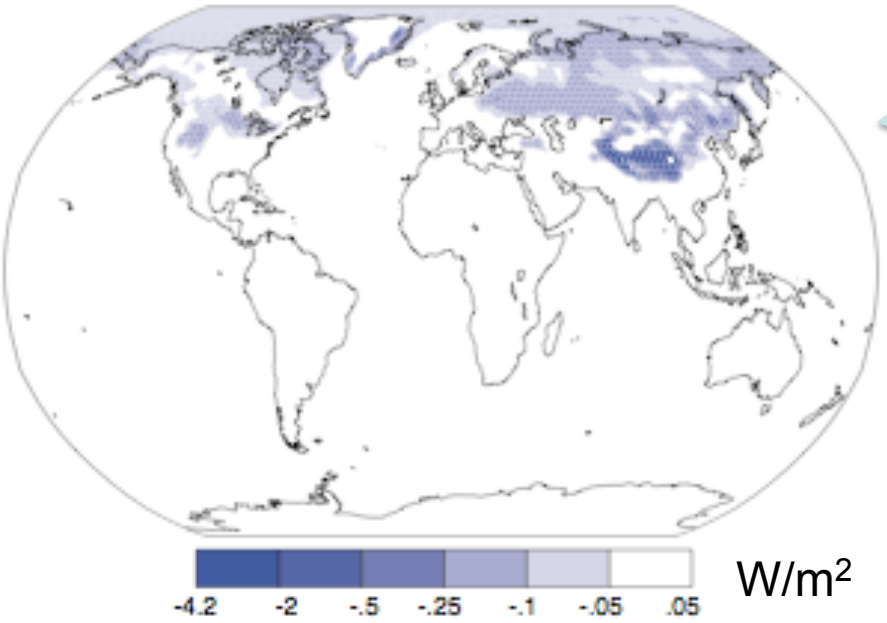
Regional temperature estimates analogous to GTP but include forcing by latitude band times RTP (RTPs from one model only thus far!)

Phasing in measures early gives strong near-term benefit

Early action relative to late has little long-term impact



Mitigation of Regional Climate Changes

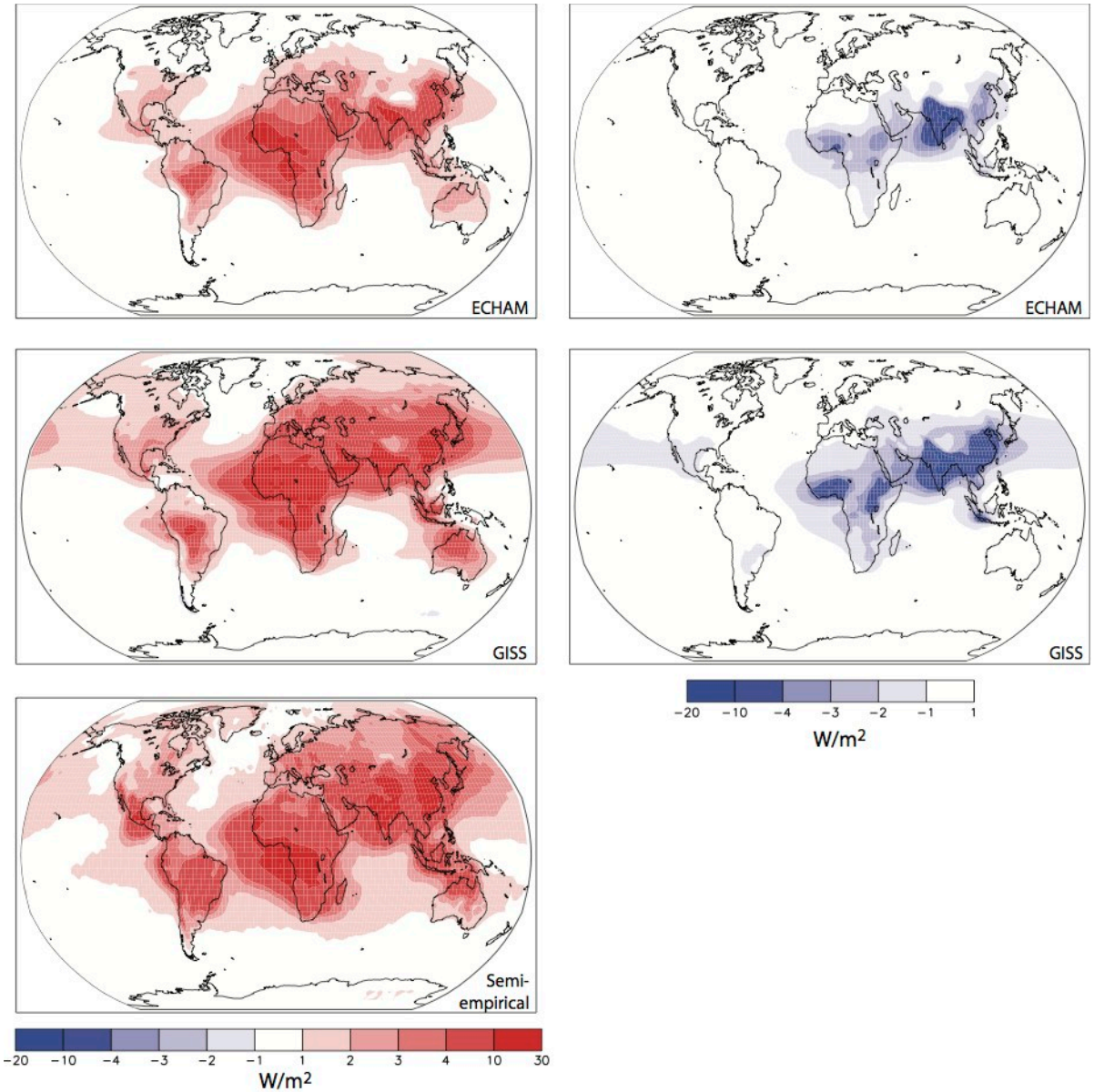


RF due to BC darkening snow & ice

Assessment estimated this would reduced Arctic warming by 0.7 ^{o}C by 2040 compared to the reference scenario, with measures taken 2010-2030. Mitigating ~2/3 of projected 1.2 ^{o}C warming

Based on % of anthropogenic BC deposition decrease due to measures times assessed BC albedo forcing

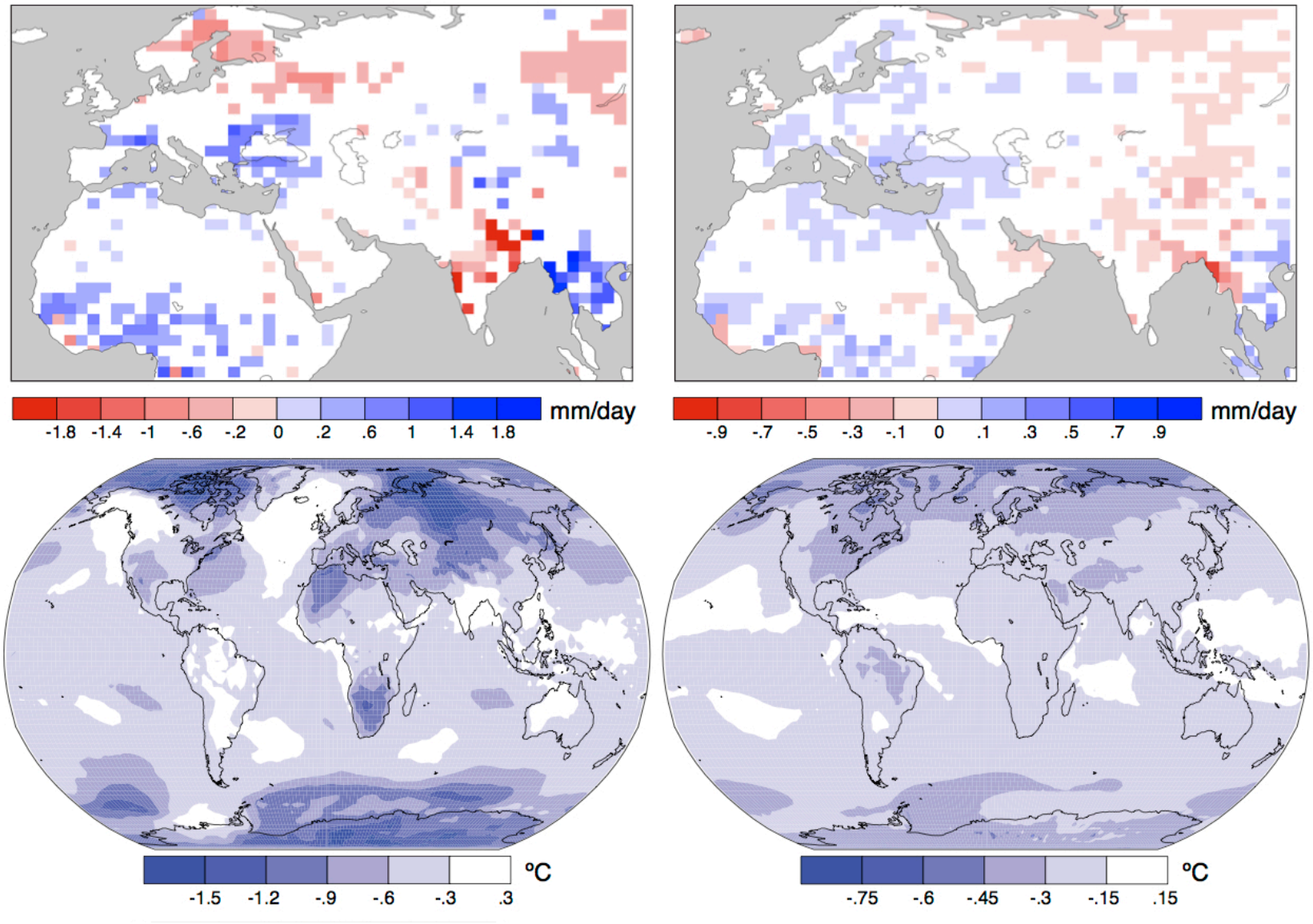
Mitigation of Regional Climate Changes



Impact of BC (& OC) on atmospheric energy absorption

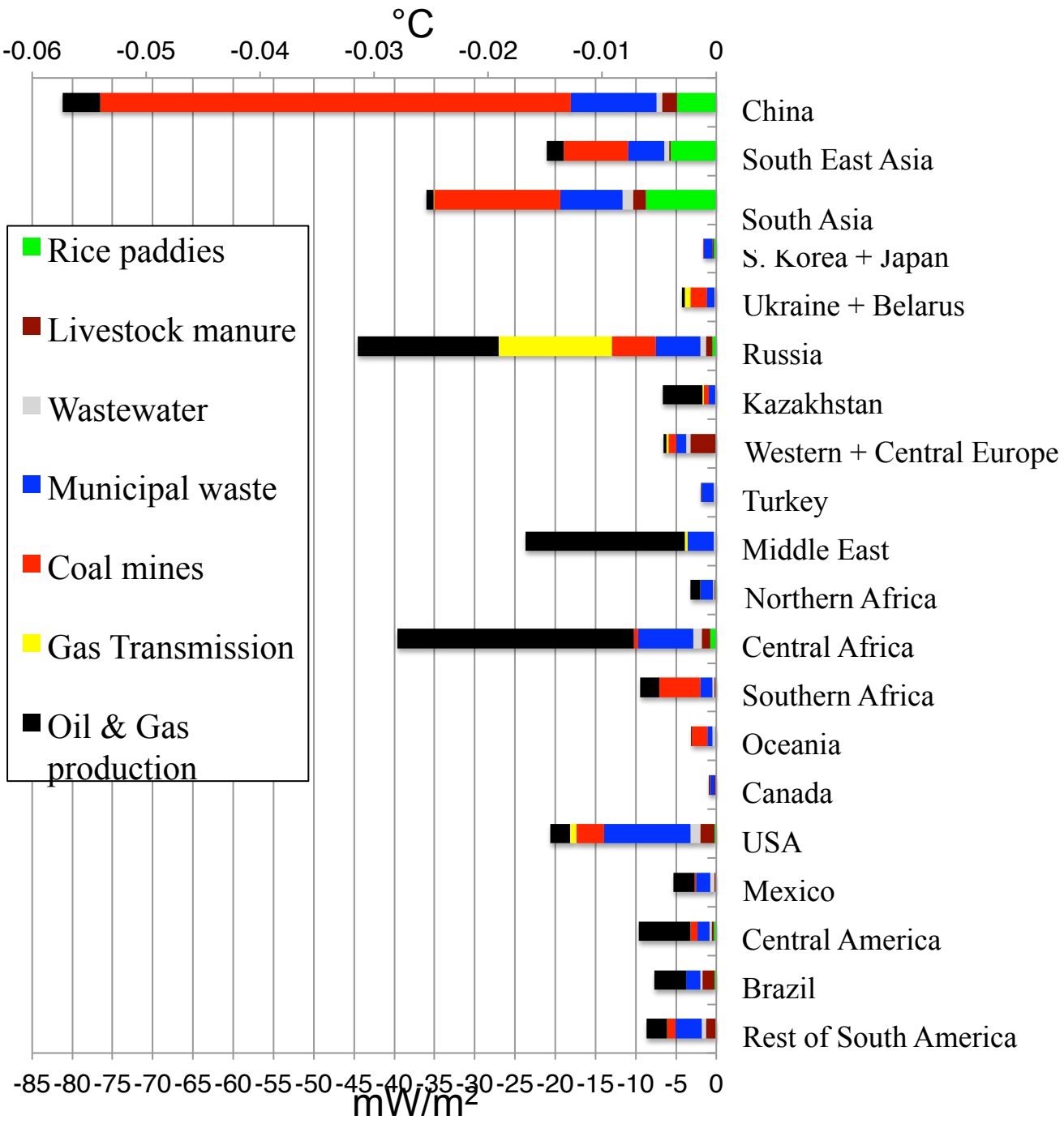
This is a primary driver of changes in rainfall, especially in the tropics and monsoon regions.

Mitigation of Regional Climate Changes



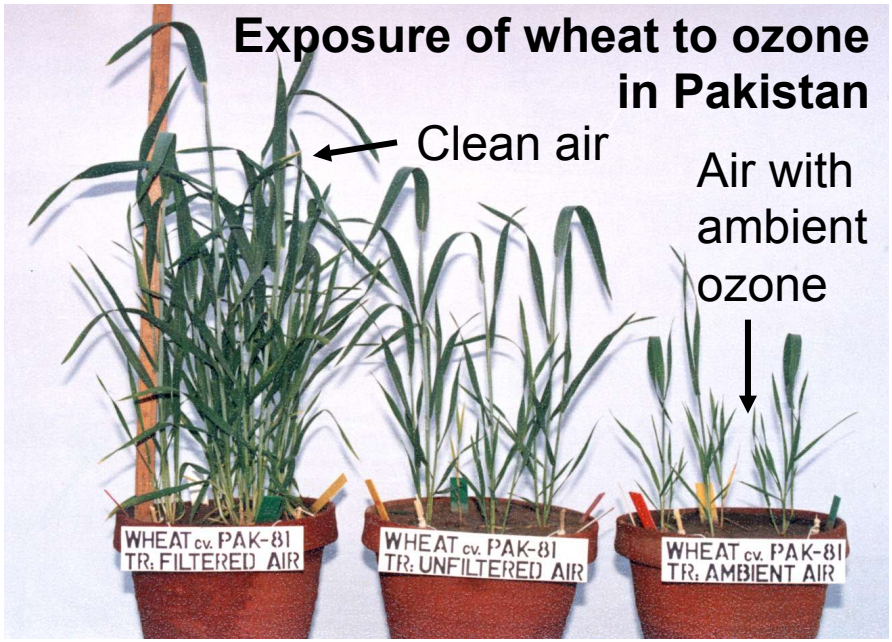
Global mean response quite consistent with simple estimates. Somewhat fortuitous (ozone and BC DRF smaller, substantial negative cloud forcing)

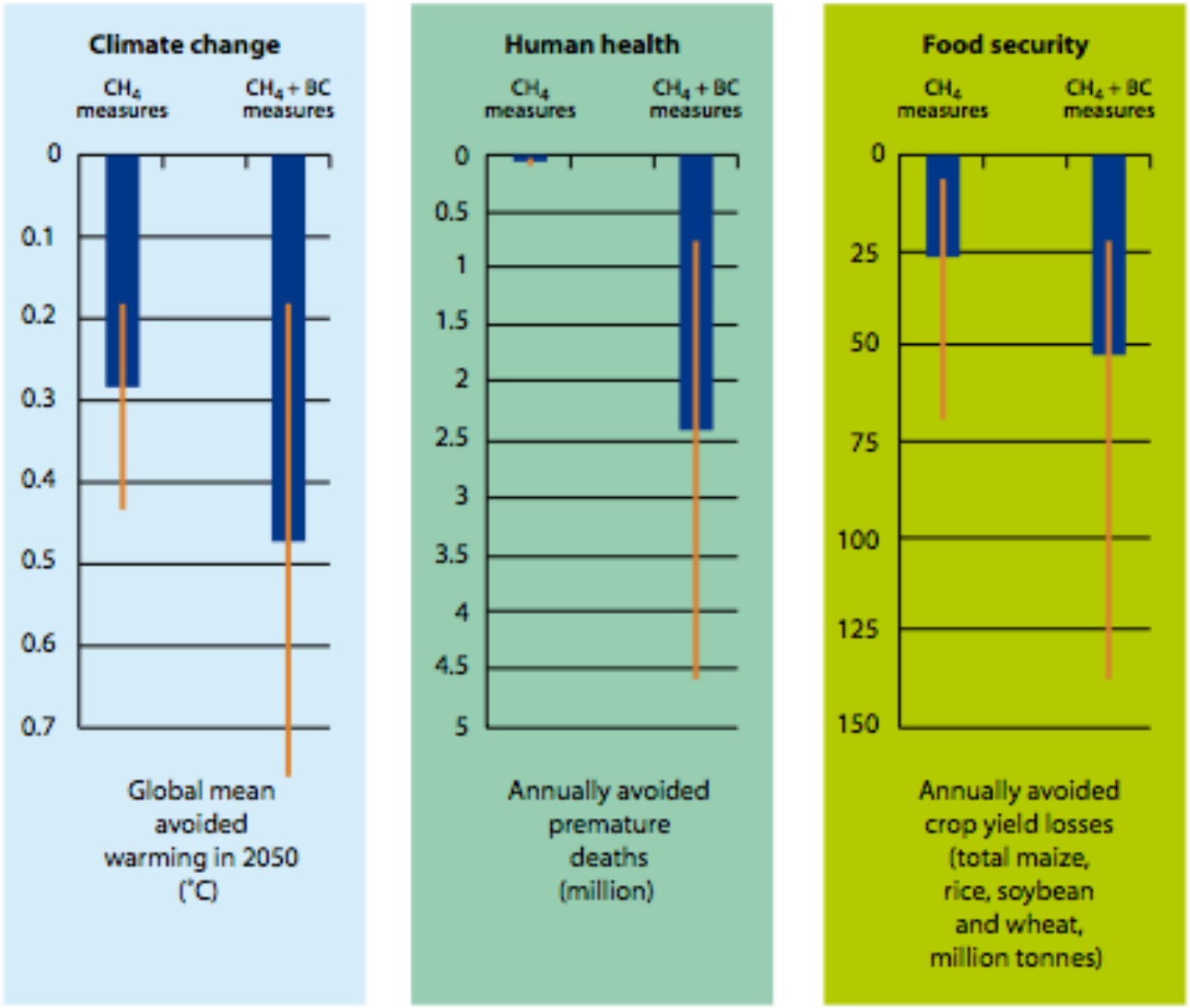
Methane's impact can be easily broken down into the contribution of each sector and region



Impact of the Measures on Health and Crop yields

- Models give **$PM_{2.5}$ and ozone concentrations** for health and crop yield impact assessment
- Concentration-response relationships from literature used to evaluate global impacts



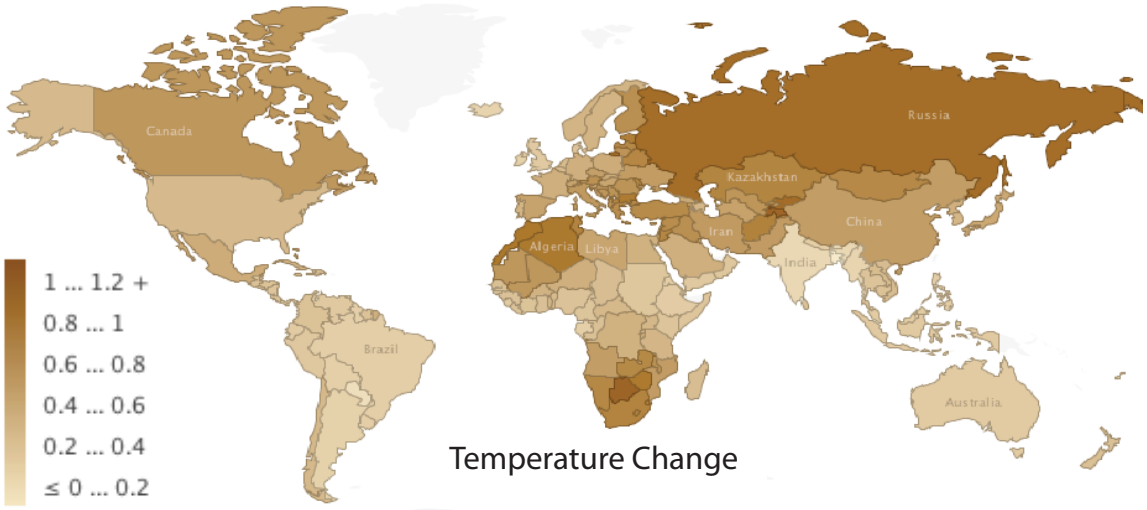


Air quality benefits for 2030 and beyond.
Health & crop benefits greatest in regions that reduce emissions.

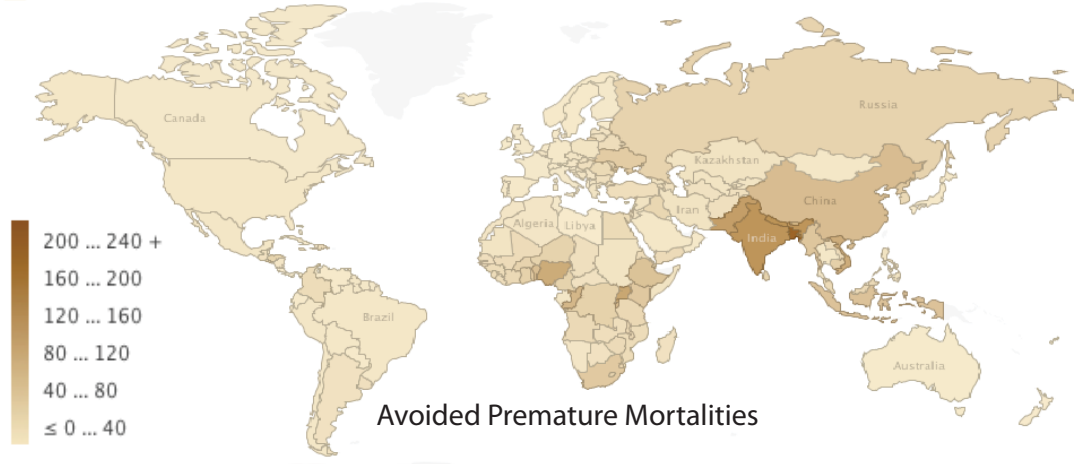
Comparison of Methane & BC Measures' Impacts

- Methane measures
  - Large benefits for global climate & agriculture
  - Comparatively small benefits for human health
  - Virtually certain

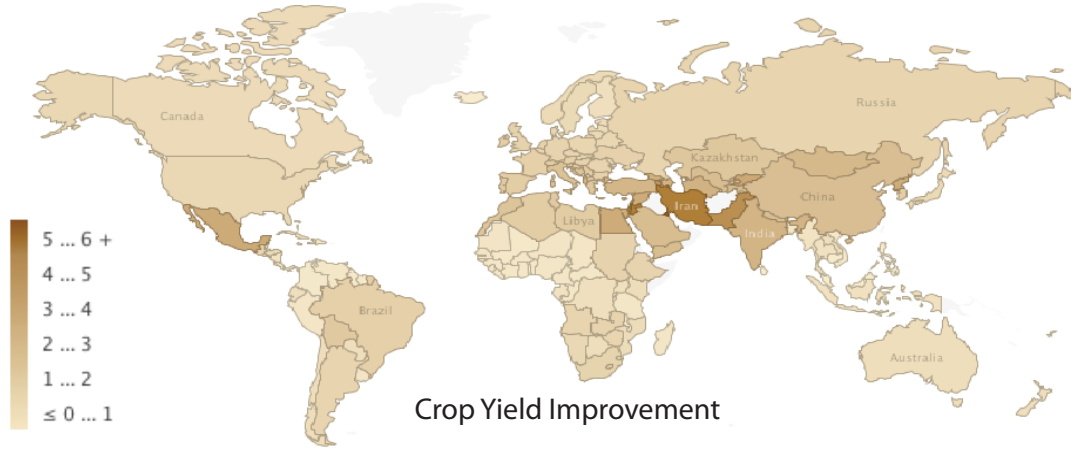
- BC Measures
  - Probable large global climate benefit, large uncertainty
  - Substantial regional climate benefits: water, cryosphere
  - Large health and agricultural benefits
  - High confidence in regional climate and air quality benefits



Temperature Change



Avoided Premature Mortalities



Crop Yield Improvement

Web

	CH_4 measures	BC Tech measures	BC Reg measures
Physical Impacts			
Avoided warming in 2050 (°C)	0.28 ± 0.10	0.12 (+0.06/–0.09)	.07 (+.04/–0.09)
Annually avoided crop yield losses (millions metric tons; sum of wheat, rice, maize, and soy)	27 (+42/–20)	24 (+72/–21)	2 (+13/–3)
Annually avoided premature deaths (thousands)	47 (+40/–34)	1720 (+1529/–1188)	619 (+639/–440)
Valuation			
Climate, billions $US	331 ± 118	142 (+71/–106)	83 (+47/–106)
($US per metric ton CH_4)	(2381 ± 850)		
Crops, billions $US	4.2 ± 1.2	3.6 ± 2.6	0.4 ± 0.6
($US per metric ton CH_4)	(29 ± 8)		
Health, billions $US	148 ± 99	3717 (+3236/–2563)	1425 (+1475/–1015)
($US per metric ton CH_4)	(1080 ± 721)		

Methane's climate impact valued using SCC from literature and GWP100.
BC measures climate impact valued using SCC and relative temperature impact of sustained emissions (equivalent to integrated future impact of 1 yr; GTP)

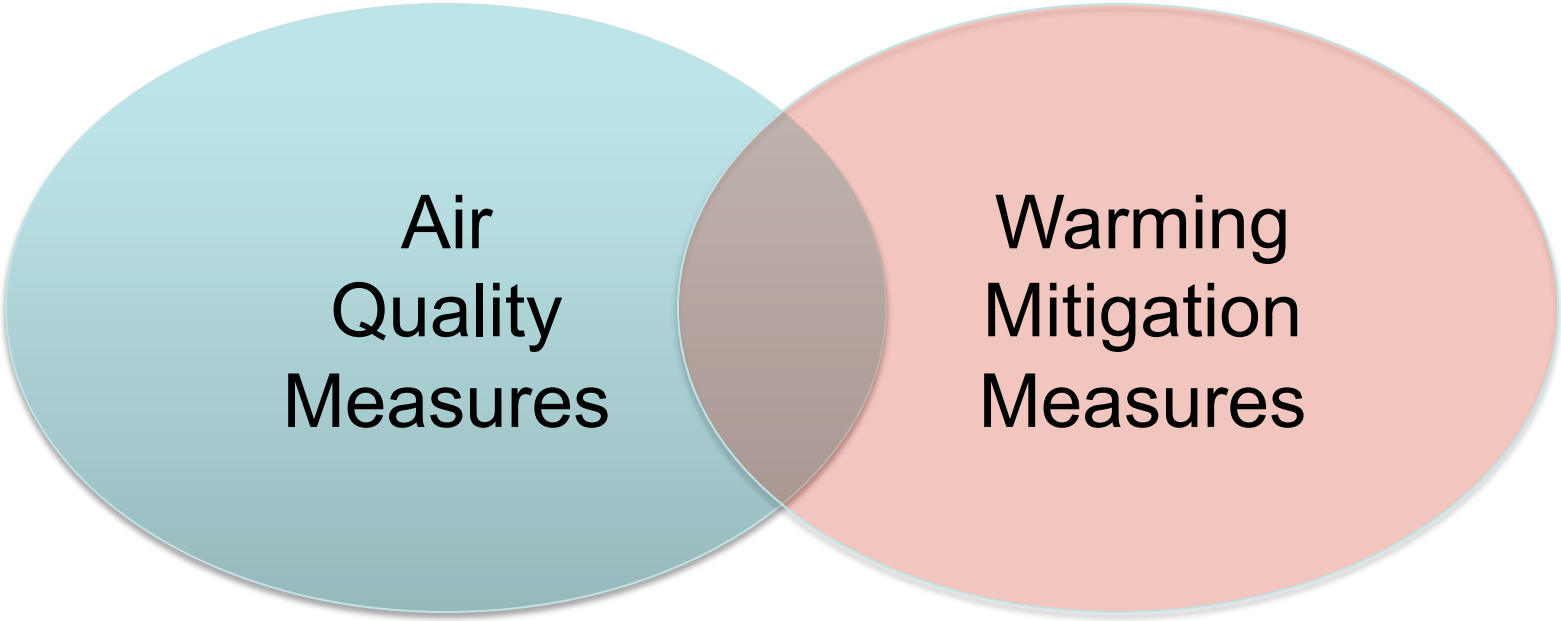
Many caveats: discounting, SLCF vs LLGHG differences, etc.

Policies to Implement the Measures

- **The identified measures are all currently in use in different regions around the world to achieve a variety of environment and development objectives.**

- **Much wider and more rapid implementation is required to achieve the full benefits identified in this Assessment.**

- Many **measures achieve cost savings** over time. However, initial capital investment could be problematic, necessitating additional strategic support and investment.

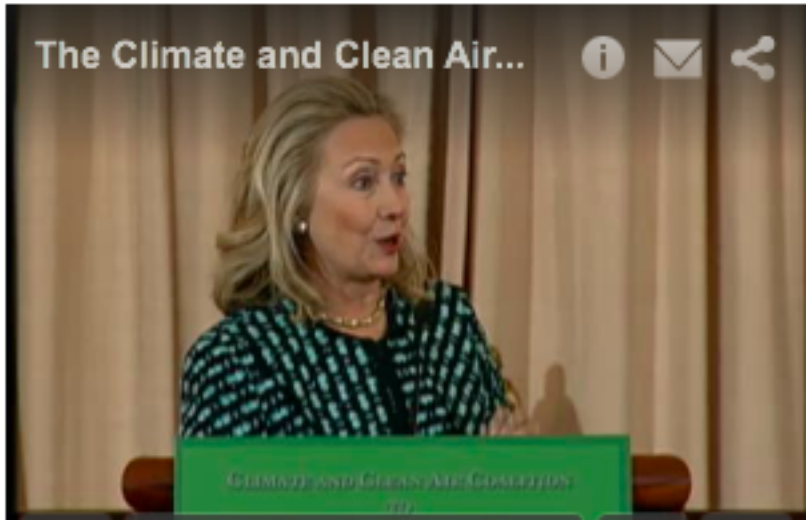


Number of measures in overlap zone is small, effects nonetheless large

Policy world response: Climate and Clean Air Coalition

U.S. DEPARTMENT OF STATE
DIPLOMACY IN ACTION

"The UN Environment Program has determined that reducing these pollutants can slow global warming by up to a half degree Celsius by 2050."



"UNEP has identified a package of 16 major actions… Every one of the actions has already been applied somewhere, and so we know they work.
Every one is based on existing technology, and fully half of them are considered low-cost interventions. So when you put all these factors together, they add up to an important opportunity that we cannot miss."

Policy world response

The New York Times

“A Second Front in the Climate War”

BBC

“Short-term climate fix risks blanking CO2”

“There is no way to effectively address climate change without reducing carbon dioxide, the most dangerous, prevalent, and persistent greenhouse gas. It stays in the atmosphere for hundreds of years. So this coalition is intended to complement – not supplant – the other actions we are, and must be, taking.” – Hillary Clinton’s remarks launching the Coalition